F
526

Advance 86

Hardware Overview

Contents

CHAPTER ONE
Advance 86 ROM BIOS

1.0 The Advance 86 ROM Basic Input/Output System resides in the top 8K of ROM on the Advance 86 system board. BIOS routines allow assembly language programs to control the hardware of the Advance 86 and perform I/O operations via the keyboard, video, cassette, printer, serial and disk subsystems.

The BIOS provides a degree of insulation from the hardware for the programmer. New peripherals can be added to the system, or production changes made without affecting compatability with your programs. If you do not go through the BIOS interface but instead choose to control the hardware directly you should be aware that there is no guarantee that your software will work on future versions of the Advance.

1.1 **Software Interrupts** BIOS routines are called through 8086 software interrupts. Each BIOS routine has its own interrupt vector. Table 1 shows the software interrupt assignments on the Advance 86.

Table 1. Advance 86 BIOS Software Interrupts

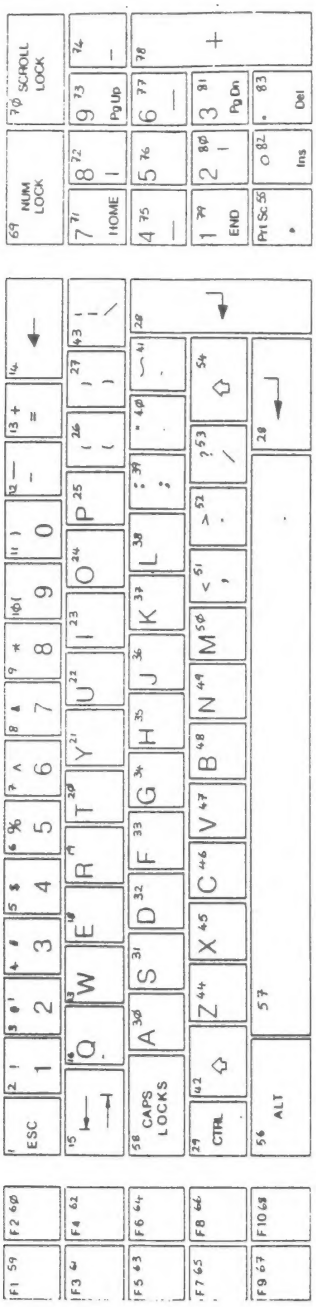
Interrupt Number	Address (Hex)	Purpose
00	00-03	Divide by 0
01	04-07	Single step
02	08-0B	NMI
03	0C-0F	Breakpoint (debug uses)
04	10-13	Overflow
05	14-17	Screen print
06	18-1B	Reserved
07	10-1F	Reserved
08	20-23	Timer Interrupt
09	24-27	Keyboard Interrupt
0A	28-2B	Reserved
0B	2C-2F	Communications Interrupt
0C	30-33	Communications Interrupt
0D	34-37	Reserved
0E	38-3B	Disk Interrupt
0F	3C-3F	Reserved Printer
10	40-43	Video I/O
11	44-47	Equipment attached
12	48-4B	Memory size
13	4C-4F	Disk I/O
14	50-53	Serial I/O
15	54-57	Cassette I/O
16	58-5B	Keyboard I/O
17	5C-5F	Printer I/O
18	60-63	Enter cassette Basic
19	64-67	Bootstrap loader
1A	68-6B	Timer I/O
1B	6C-6F	CTRL — BREAK
1C	70-73	Timer Tick
1D	74-77	Video init table
1E	78-7B	Disk base parameter table
1F	7C-7F	Graphics characters pointer

Note that the other vectors documented in Table 1 are central to the correct operation of the machine.

The BIOS I/O routines are given in section 1.5, BIOS calls.

Parameters are passed and returned in the 8086 registers.

1.2 Keyboard Encoding



The keyboard routine in ROM BIOS converts keyboard scan codes into 'extended' ASCII.

Table 2 shows the character codes which are passed through the BIOS keyboard routine to the application program.
Note that 'NA' indicates that the combination is suppressed in the keyboard routine. The two byte extended codes consist of ASCII 0, plus a second code as indicated.

Table 2. Character Codes

Key	LOWER CASE	UPPER CASE	CTRL	ALT
1	ESC	ESC	ESC	NA
2	1	1/2	NA	(0,120)
3	2	@	(0,3)	(0,121)
4	3	#	NA	(0,122)
5	4	$	NA	(0,123)
6	5	%	NA	(0,124)
7	6	^	(030)	(0,125)
8	7	&	NA	(0,126)
9	8	*	NA	(0,127)
10	9	(	NA	(0,128)
11	0	)	NA	(0,129)
12	-	_	(031)	(0,130)
13	=	+	NA	(0,131)
14	(008)	(008)	(127)	NA
15	(009)	(0,15)	NA	NA
16	q	Q	(017)	(0,16)
17	w	W	(023)	(0,17)
18	e	E	(005)	(0,18)
19	r	R	(018)	(0,19)
20	t	T	(020)	(0,20)
21	y	Y	(025)	(0,21)
22	u	U	(021)	(0,22)
23	i	I	(009)	(0,23)
24	o	O	(015)	(0,24)
25	p	P	(016)	(0,25)
26	[	{	(027)	NA
27	]	}	(029)	NA
28	(013)	(013)	(010)	NA
29	NA	NA	NA	NA
30	a	A	(001)	(0,30)
31	s	S	(019)	(0,31)
32	d	D	(004)	(0,32)
33	f	F	(006)	(0,33)
34	g	G	(007)	(0,34)

Key	LOWERCASE	UPPERCASE	CTRL	ALT
35	h	H	(008)	(0,35)
36	j	J	(010)	(0,36)
37	k	K	(011)	(0,37)
38	l	L	(012)	(0,38)
39	;	:	NA	NA
40	'	"	NA	NA
41	`	~	NA	NA
42	NA	NA	NA	NA
43	\	|	(028)	NA
44	z	Z	(026)	(0,44)
45	x	X	(024)	(0,45)
46	c	C	(003)	(0,46)
47	v	V	(022)	(0,47)
48	b	B	(002)	(0,48)
49	n	N	(014)	(0,49)
50	m	M	(013)	(0,50)
51	,	<	NA	NA
52	.	>	NA	NA
53	/	?	NA	NA
54	NA	NA	NA	NA
55	*	PrtSc (See 1.4)	(0,114)	NA
56	NA	NA	NA	NA
57	SPACE	SPACE	SPACE	SPACE
58	NA	NA	NA	NA
59	(0,59)	(0,84)	(0,94)	(0,104)
60	(0,60)	(0,85)	(0,95)	(0,105)
61	(0,61)	(0,86)	(0,96)	(0,106)
62	(0,62)	(0,87)	(0,97)	(0,107)
63	(0,63)	(0,88)	(0,98)	(0,108)
64	(0,64)	(0,89)	(0,99)	(0,109)
65	(0,65)	(0,90)	(0,100)	(0,110)
66	(0,66)	(0,91)	(0,101)	(0,111)
67	(0,67)	(0,92)	(0,102)	(0,112)
68	(0,68)	(0,93)	(0,103)	(0,113)
69	NA	NA	Pause (See 1.4)	NA
70	NA	NA	Break (See 1.4)	NA

533

Table 3 gives the character codes for keys 71 to 83. Note that these keys only have meaning in lowercase, in Numlock (or shifted) or in Ctrl states. The shift key reverses temporarily the current Numlock states.

Table 3

Key	Numlock	Lowercase	ALT	CTRL
71	7	(0,71)	NA	(0,117)
72	8	(0,72)	NA	NA
73	9	(0,73)	NA	(0.119)
74	-	=	NA	NA
75	4	(0,75)	NA	(0,115)
76	5	NA	NA	NA
77	6	(0,77)	NA	(0,116)
78	+	+	NA	NA
79	1	(0,79)	NA	(0,117)
80	2	(0,80)	NA	NA
81	3	(0,81)	NA	(0,118)
82	0	Ins	NA	NA
83	-1	(0,83)	See 1.4	See 1.4

1.3 Shift States

The keyboard routine handles the shift states transparently to the application program. The current set of active shift states are available by calling INT 16H (keyboard I/O)

Table 4. Shift States

Key	Functions
Shift	Shifts keys 2-13, 15-27, 30-41, 43-53, 55, and 59-68 to uppercase. (Lowercase if in Caps-Lock state). Reverses the Num Lock or non-Num-Lock state of keys 71-73, 75, 77, and 79-83.
Ctrl	Shifts keys 3, 7, 12, 14, 16-28, 30-38, 43-50, 55, 59-71, 73, 75, 77, 79 and 81 to the Ctrl state. Used with the Scroll Lock key to cause 'break' function. Used with the Num Lock key to cause the 'pause' function.
Alt	Shifts keys 2-13, 16-25, 30-38, 44-50 and 59-68 to the Alt state. Alt allows you to enter any character code from 0 to 255 into the system from the keyboard. To do this, hold down the Alt key and type the decimal value of the characters desired using the numeric keypad. Note that you must type all three digits. Release the Alt key.

534

Caps Lock	Shifts keys 16-25, 30-38 and 44-50 to uppercase. A second press of key reverses the action.
Scroll Lock	INT 16H merely records the current shift state of the Scroll Lock key. Its interpretation is left to the applications program.

Note: If combinations of the Alt, Ctrl, and Shift keys are pressed, and only one is valid, the order of precedence is: the Alt key is first, the Ctrl key second and the Shift key third. The only valid combination is Alt and Ctrl which is used in the system reset.

1.4 Special Handling

System reset	Pressing the Alt, Ctrl and Del keys together will initiate a system reset.
Break	Pressing the Ctrl and Break keys together will initiate interrupt hex 1A. The extended characters (AL = hex 00, AH = 00) will be returned.
Pause	Pressing Ctrl and Num Lock keys together will cause the keyboard interrupt routine to loop and wait for any key (except Num Lock) to be pressed.
Print Screen	Pressing Shift and PrtSc (key 55) together will cause an interrupt to invoke the print screen routine.

1.5 BIOS CALLS

Print Screen (INT 5)

This interrupt prints a copy of the current text screen. It maintains screen status. It can be invoked from the DOS level by pressing Shift-PrtSc on the keyboard. A status byte at 0050:0000H is maintained by this routine.

0050:00000	= 0	Print screen has not been called or successful print screen operation.
	= 1	Print screen is in progress
	= OFFH	Printer error

Video I/O (INT 10)
These routines provide the screen interface.

(AH)=0 Set screen mode
(AL)=0 40 x 25 BW
(AL)=1 40 x 25 Colour
(AL)=2 80 x 25 BW
(AL)=3 80 x 25 Colour
(AL)=4 320 x 200 Colour
(AL)=5 320 x 200 BW
(AL)=6 640 x 200 BW
(AL)=7 80 x 25 BW with external monochrome card.

The BW modes operate as colour modes, but the colour burst signal is not enabled.

(AH)=1 Set cursor type
(CH) = Bits 4-0 = start line for cursor
(CL) = Bits 4-0 = end line for cursor

(AH)=2 Set cursor
(DH,DL) = row, column
(BH) = page number

(AH)=3 Read cursor
(BH) = page number
On exit (DH,DL) = row, column of current cursor
(CH,CL) = cursor mode currently set.

(AH)=4 Read light pen
On exit
(AH) = 0 — light pen switch not down/not triggered
(AH) = 1 — valid light pen value in registers
(DH,DL) = row, column of character LP position
(CH) = Raster line (1-199)
(BX) = pixel column (0-319,639)

(AH)=5 Select current display page (Valid only for text modes)
(AL) = new page value (0-7 for 40 x 25, 0-3 for 80 x 25).

(AH)=6 Scroll current page up
(AL) = number of lines, input lines blanked at bottom of window

Note: AL = 0 means blank entire window

(CH,CL) = row, column of upper left corner of scroll
(DH,DL) = row, column of lower right corner of scroll
(BH) = character attribute to be used on blank line

In 40 x 25 or 80 x 25 text modes, the value set for palette colour 0 indicates the border colour to be used (0-31).

(AH)=12 Write pixel
(DX) = row number
(CX) = column number
(AL) = colour value
If bit 7 of AL = 1, then the colour value is exclusive OR'd with the current contents of the pixel.

(AH)=13 Read pixel
(DX) = row number
(CX) = column number
(AL) = returns the pixel read

(AH)=14 Write teletype
(AL) = character to write
(BL) = foreground colour in graphics mode
(BH) = display page in text mode

(AH)=15 Current video state
Returns the current video state
(AL) = mode currently set
(AH) = number of character columns on screen
(BH) = current display page

On INT 10 calls registers CS, SS, DS, ES, BX, CX, DX are preserved during call.

Equipment Determination (INT 11)

On exit

(AX) is set to indicate what peripheral devices are present on the system.

Bit 15, 14 = number of parallel ports
Bit 13 unused
Bit 12 = game I/O
Bit 11, 10, 9 = number of RS232 ports
Bit 8 unused
Bit 7, 6 = number of disk drives
    00 = 1, 01 = 2.
Bit 5, 4 = video mode
    00 — unused
    01 — 40 x 25 BW using colour card
    10 — 80 x 25 BW using colour card
    11 — 80 x 25 BW using external monochrome card
Bit 3, 2 = Unused
Bit 1 = 50Hz/60Hz frame rate
Bit 0 = 86b expansion unit is attached

Memory Check (INT 12)
This routine calculates the amount of memory in the system.

One exit
(AX) = number of contiguous 1K blocks of memory.

Disk I/O (INT 13)

On entry

(AH)=0 Reset disk system
Hard reset to FDC.

(AH)=1 Read the disk status into (AL).

(DL) — Drive number (0-3)
(DH) — Head number (0-1)
(CH) — Track number (0-39)
(CL) — Sector number (1-9)
(AL) — Number of sectors (0-9)

(ES:BX) — Address of data buffer

(AH)=2 Read sectors into memory
(AH)=3 Write sectors from memory
(AH)=4 Verify sectors
(AH)=5 Format track.
For format, the buffer pointer (ES, BX) must point to the address fields for the track. Each field is composed of 4 bytes — track number, Head number, Sector number and Number of bytes per sector (00=128, 01=256, 02=512, 03=1024). There must be one entry for each sector on the track.

0:0078H — 0:007BH points to current disk parameters

On exit

AH = status
Status bits are defined in Table 5, page 1-26

Carry is set if operation failed.

Registers DS, BX, DX, CH, CL are preserved.
AL = number of sectors read
(AL may not be correct if time out error occurs).

Note: if an error is reported by the disk code, reset the disk, and retry the operation. On Read accesses, no motor start delay is allowed for so up to three retries are recommended on reads to ensure that the problem is not due to disk motor start-up.

RS232 I/O (INT 14)

(AH)=0 Initialise the serial port.
AL = initialisation parameters.

Bit	7 6 5	4 3	2	1 0
	----Baud rate---	- Parity--	Stopbit	Word Length
	000 — 110	00 — None	0 — 1	10 — 7 Bits
	001 — 150	01 — Odd	1 — 2	11 — 8 Bits
	010 — 300			
	011 — 600			
	100 — 1200			
	101 — 2400			
	110 — 4800			
	111 — 9600			

On exit serial status is returned in (AX).

(AH)=1 Send the character in (AL)
(AL) register is preserved

On exit, bit 7 of AH is set if the routine was unable to transmit the character. The remainder of AH = the current status of the line.

(AH)=2 Receive a character in (AL)

On exit, AH has the current line status.
Error bits. If bit 7 = 1, data set ready was not flagged.

(AH)=3 Return the serial status in (AX).
AH contains the line status
Bit 7 = time out
Bit 6 = TSR empty
Bit 5 = THR empty
Bit 4 = break
Bit 3 = framing error
Bit 2 = parity error
Bit 1 = overrun error
Bit 0 = data ready

AL contains the modem control status

Bit 7 = received line signal detect
Bit 6 = ring indicator
Bit 5 = data set ready
Bit 4 = clear to send
Bit 3 = delta receive line signal detect
Bit 2 = trailing edge ring detector
Bit 1 = data set ready
Bit 0 = clear to send

On entry (DX) = Which RS232 port (0,1)
On exit AX Status, as above. All other registers are preserved.

Cassette I/O (INT 15)

(AH)=0 Turn cassette motor on
(AH)=1 Turn cassette motor off
(AH)=2 Read 1 256 byte blocks from cassette
(ES, BX) = pointer to data buffer
(CX) = count of bytes to read

On exit

(ES, BX) = pointer to last byte read + 1
(DX) = count of bytes read
Carry bit is set if an error occurred and nature of error.
(AH) = 01 if CRC error.
= 02 if data transitions lost.
= 04 if no data was found.

(AH)=3 Write 256 byte blocks to cassette
(ES, BX) = pointer to data buffer
(CX) = count of bytes to write

On exit

(EX, BX) = pointer to last byte written + 1
(CX) = 0

Keyboard I/O (INT 16)

On entry

(AH)=0 Read next ASCII character. Return the ASCII code in (AL), scan code in (AH).

(AH)=1 See if a keyboard character is available.
(ZF) = 0 — character is available
(ZF) = 1 — no character is available
(AX) = next available character bit remains in keyboard buffer

(AH)=2 Return the current shift status in AL.
See Table 6 page 1-26

On exit

AX, Flag register changed. All other registers preserved.

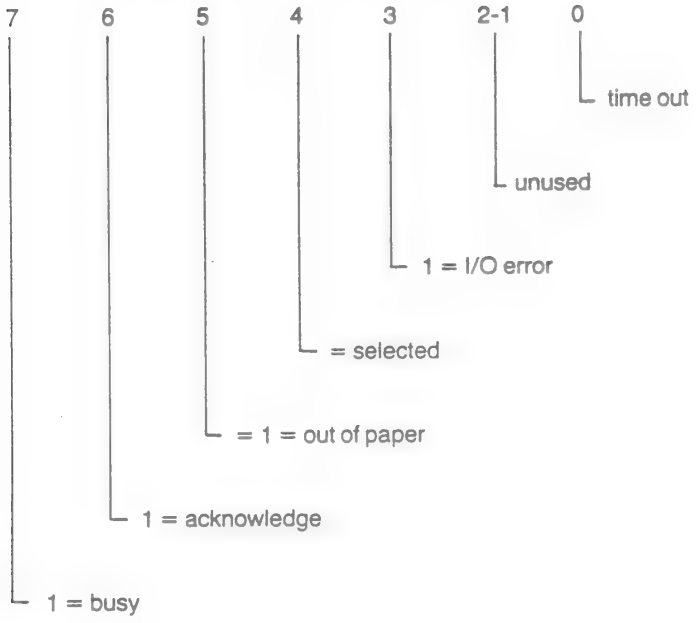
Printer I/O (INT 17)

On entry

(AH)=0 Send the character in (AL) to the parallel port.
On return, AH = 1 if character could not be sent. Other bits set as status call

(AH)=1 Initialise the parallel port
Returns with (AH) set with status

(AH)=2 Read the parallel port status into (AH)



(DX) = parallel port number (0-2).

On exit

AH = status. All other registers preserved.

Bootstrap leader (INT 19)

On Advance 86b systems track 0, sector 1 is read into the boot location (0000:7C00) and control transferred there.

On an Advance 86a or if the disk boot fails, control is transferred to the cassette basic entry point.

Time of Day I/O (INT 1A)
On entry

(AH)=0 Return current clock setting
On exit CX = high portion of count
DX = low portion of count
AL = 0 if timer has not passed 24 hours since last read.
<> 0 if on another day.

(AH)=1 Set clock.
CX = high portion of count
DX = low portion of count

Note: Counts occur approximately 18.2 / sec.

1.6 Advance 86 Memory Map

```
FFFF:0000 ----------------------------------------------------------------------
          Advance 86 Self-test routines, ROM BIOS (8K bytes)
FE00:0000 ----------------------------------------------------------------------
          Advance 86 Cassette Basic (56K bytes)
F000:0000 ----------------------------------------------------------------------
          Reserved
BC00:0000 ----------------------------------------------------------------------
          Video RAM (16K bytes)
B800:0000 ----------------------------------------------------------------------
          Reserved
A000:0000 ----------------------------------------------------------------------
          Top of possible RAM memory (640K bytes)
          Transient portion of COMMAND.COM (overlaid if necessary)
          Applications program
          Program segment prefix (100H bytes)
          Resident portion of COMMAND.COM
          Resident device drivers
          DOS Buffers
          MSDOS.SYS
          IO.SYS
0070:0000
          ROM BIOS data
0040:0000
          8086 Software Interrupt Vectors
0000:0000
```

Advance 86 I/O Address Map

Address (Hex)	
00-0F	8237 DMA Chip
20	8259A Interrupt Controller
22★	8259A IMR Register; ★ or 21 on 86 Rev. 8 (redundantly decoded)
40 - 43	8253 TIMER
60 - 63	8255 PPI
80 - 83	DMA Page registers
AX	NMI mask register. 00 disable NMI. 80H enable NMI. Disabled at power on.
200 - 20F	Game I/O logic
378 - 37F	Parallel Printer Interface
3DO - 3DF	6845 Video Logic
3FO - 3F7	8272 Disk Controller Logic
3F8 - 3FF	8250 Asynchronous Communications Element

X = don't care

8237 DMA Controller

Channel Number	Purpose
0	I/O Channel RAM Refresh
1	Available on I/O Channel
2	Diskette Controller
3	Available on I/O Channel

8259A Programmable Interrupt Controller

Interrupt Level	Vector Number	Purpose
0	8	Timer Channel 0
1	9	Keyboard
2	A	Unused
3	B	Asynchronous Comms.
4	C	Reserved
5	D	Reserved
6	E	Diskette Controller
7	F	Parallel Printer

8253 Interval Timer

Timer Number	Purpose
0	Time of day interrupt
1	RAM refresh on I/O channel
2	Tone output

8255 PPI

Address (Hex)

60 Input Keyboard scan codes
61 Output
Bit 0 Timer channel 2 gate (speaker control)
1 Speaker (direct control)
2 Not used
3 Cassette motor off (active high)
4 Enable parity check on system memory (active low)
5 Enable parity check on I/O memory (active low)
6 Hold keyboard clock low (active low)
7 If high — clear keyboard; if low, enable keyboard

62 Input
Bit 0 Switch 1 — B expansion unit fitted (1)
1 Switch 2 — 50hz (0), 60hz (1) frame rate
2 Switch 3 — Reserved
3 Switch 4 — Reserved
4 Cassette data in (active high)
5 Timer channel 2 (active high)
6 Parity fault on I/O memory (active high)
7 Parity fault on System memory (active high)

63 8255 Command Register initialised to 99H by ROM BIOS

Game I/O Logic

201H Input
Bit 0 Analogue input 1
1 Analogue input 2
2 Analogue input 3
3 Analogue input 4
4 Button 1 (active low)
5 Button 2 (active low)
6 Button 3 (active low)
7 Button 4 (active low)

201H Output Begin conversion

To read game I/O, output any value to 0201H. Bits 0-3 will go low. After a time period proportional to the resistance value across it each bit will return to 1.

Parallel Printer Interface

Address

378H Output
Bit 0 DB0 Pin 2
1 DB1 Pin 3
2 DB2 Pin 4
3 DB3 Pin 5
4 DB4 Pin 6
5 DB5 Pin 7
6 DB6 Pin 8
7 DB7 Pin 9

379H Input

Bit 0 Not used
1 Not used
2 Not used
3 Printer error (active low) Pin 15
4 Select (active high) Pin 13
5 Out of paper (active high) Pin 12
6 Acknowledge (active low) Pin 10
7 Busy (active high) Pin 11

37AH Output

Bit 0 Strobe (active low) Pin 1
1 Auto LF (active low) Pin 14
2 Printer init. (active low) Pin 16
3 Printer select (active low) Pin 17
4 Enable printer interrupt★ (active high)
5 Not used
6 Not used
7 Not used

★ If bit 4 is 1, an interrupt will be generated when Acknowledge (Pin 10) goes low.

Video Logic

Address

3D4H 6845 CRT Controller Address Registers

3D5H 6845 CRT Controller Data Registers

3D8H Output Mode Select

Bit 0 40 x 24 (0) or 80 x 25 (1) display
1 Text (0) or Graphics (1) display
2 Colour (0) or Black and white (1) display
3 Disable (0) or enable (1) the video display
4 320 x 200 (0) or 640 x 200 (1) display
5 16 background colours (0) or flashing in text modes (1)
6 Not used
7 Not used

3D9H Output Colour Select

Bit 0 Blue border/background colour select
1 Red border/background colour select
2 Green border/background colour select
3 High intensity border/background colour select
4 Select high intensity background colours in text modes (active high)
5 Select Colour palette 0 or 1 in 320 x 200 graphics
6 Not used
7 Not used

Table 5.

Disk Status Byte.

Code (hex)	Error
01	Illegal command
02	Bad address mark
03	Write protect error
04	Sector not found
08	DMA overrun
09	DMA operation attempted to cross 64K boundary
10	CRC Read error
20	FDC failure
40	Seek failed
80	No response from FDC

Table 6.

Keyboard Shift Status

Bit position (Hex)	Function
0	Right shift key pressed
1	Left shift key pressed
2	CTRL key pressed
3	Alt key pressed
4	Scroll lock mode
5	Num Lock mode
6	Caps lock mode
7	Insert mode
8	Not used
9	Not used
A	Not used
B	Hold mode
C	Scroll lock pressed
D	Num Lock pressed
E	Caps lock pressed
F	Insert key pressed.

3DAH Input Video Status
Bit 0 Display buffer may be accessed in 80 x 25 mode (active high)
1 Light Pen Trigger set (active high)
2 Light Pen Switch (active low)
3 Alpha video signal

3DBH Output Clear Light Pen latch

3DCH Output Preset Light Pen latch

Floppy disk logic

Address

3F2H Output
Bit 0 Drive Select low 00-Drive A 01-Drive B
1 Drive Select high 10-Drive C 11-Drive D
2 Reset (active low)
3 Enable DMA + Interrupt requests (active high)
4 Drive A Motor enable (active high)
5 Drive B Motor enable (active high)
6 Drive C Motor enable (active high)
7 Drive D Motor enable (active high)

3F4H 8272 FDC Status Register

3F5H 8272 FDC Data Register

Asynchronous Communications logic

03F8H 8250 TX/RX/Divisor latch LSB
03F9H 8250 Divisor latch/Interrupt enable register
03FAH 8250 Interrupt identification register
03FBH 8250 Line control register
03FCH 8250 Modem control register
03FDH 8250 Line status register
03FEH 8250 Modem status register

Index

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